THE EVOLUTION OF ORGANIC MANTLES ON INTERSTELLAR GRAINS

by

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Observations of the galactic center source IRS 7 (Butchart *et al.* 1986) revealed the presence of interstellar absorption features at 3, 3.26 and 3.4 μm. In fig. 1 these observations are compared to the spectrum of an amorphous carbon material, being a mixture of saturated and unsaturated hydrocarbons. The interstellar 3.4 μm band is matched by the C−H stretching mode of tetrahedrally bonded carbon ($R_3 - C - H$, here 'R' denotes either an H atom or an organic carbon chain). The 3.26 μmfeature seems to correspond with the C−H stretching mode of trigonally bonded carbon ($R = CH - R$) at 3.28 μm. Thus the features seen towards IRS 7 point to the presence of solid organics in the interstellar medium. The deduced amount of organic carbon is about 30 % of the cosmic abundance, while the amount of organic oxygen is much smaller. Thus a hydrocarbon-type, unsaturated material is indicated.

The observed broad 3 μm band can be matched very well with the H_2O band in a laboratory ice mixture (fig. 1). Also the presence of a CO line in the spectrum of Sgr AW (Willner *et al.* 1979) points to molecular cloud extinction towards the galactic center. The H_2O/CO line intensity ratio is consistent with the ratio's observed in local clouds.

Direct data on the composition of interstellar grains was obtained by the PUMA mass spectrometer on board the Vega 1 Halley mission (Kissel and Krueger 1987). It was found that an important fraction of the grains in the coma consisted of unsaturated hydrocarbon type of materials, consistent with the IRS 7 observations.

By laboratory simulation of the chemical processes on dust grains we have investigated how solid organic materials can be produced in the interstellar medium. Our model as well as the observational constraints were discussed by Schutte (1988). The ice mantles that accrete on grains in molecular clouds, consisting primarily of H_2O, CO, H_2CO, NH_3 and O_2, are irradiated by the internal UV field, resulting in the storage of radicals upon photodissociation of the original molecules. Transient heating events lead to the production of oxygen-rich organic species by recombination reactions. The experiments indicated that in this way the observed amount of organic material can be produced

if a grain passes a few times through a molecular cloud during its life.

After the destruction of the cloud the grains enter a more diffuse medium. Here they are subjected to the interstellar UV field as well as to colissions with atomic hydrogen. Experiments show that the intense photoprocessing results in the removal of small species like H_2O and NH_3 as well as in carbonization of the organic molecules. Contrary to this, the atomic H flux will maintain a certain hydrogen level in the mantle. These processes likely convert the original, oxygen-rich organics into an unsaturated hydrocarbon type material such as that observed towards IRS 7 and in Comet Halley grains.

References :

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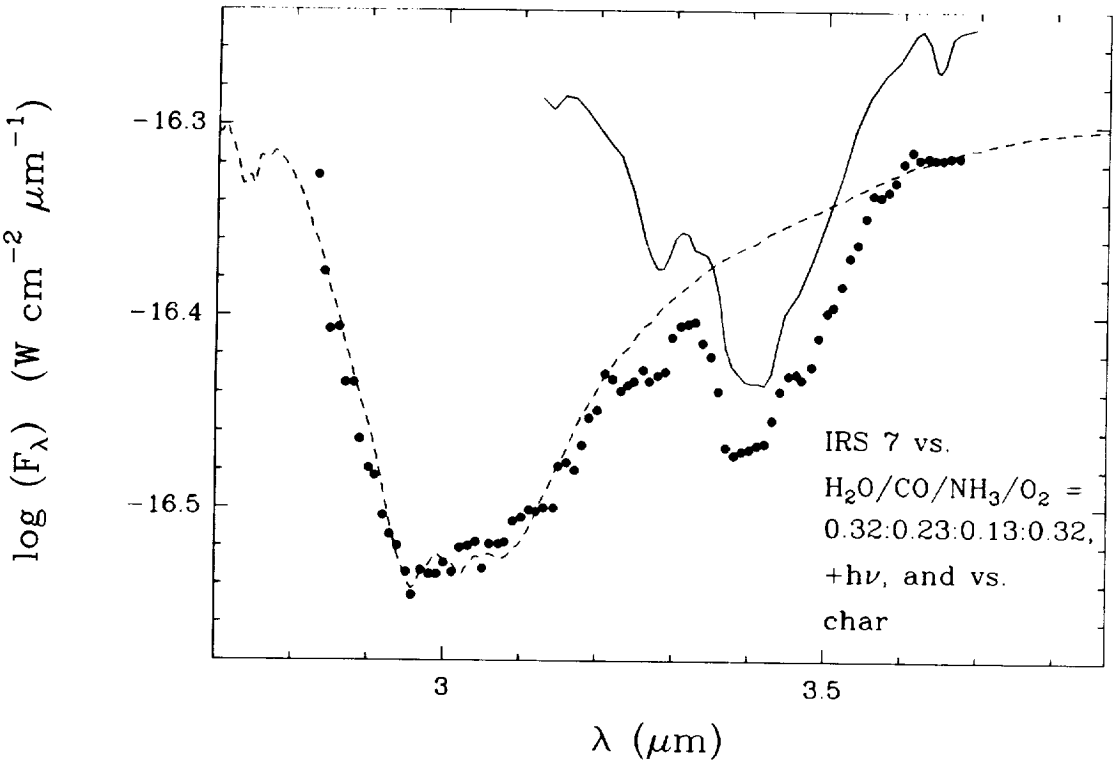

Figure 1. A comparison of the IR spectrum of IRS 7 with the spectra of an amorphous carbon material (solid line) and the H_2O feature of the ice mixture $H_2O/CO/NH_3/O_2$ = 0.32:0.23:0.13:0.32 (dashed line).